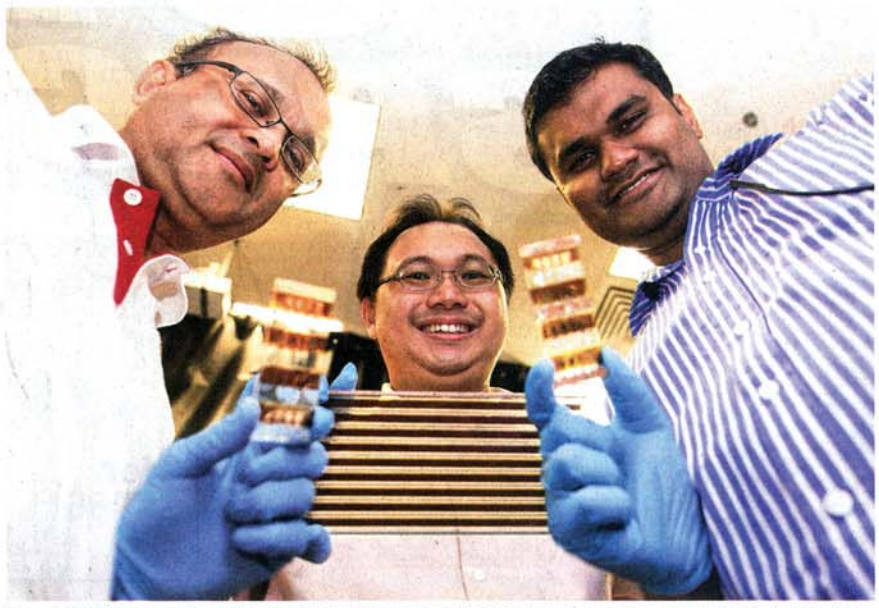
BIG QUESTION HOW WHALES GOT SO GIGANTIC **B11**

SCIENCE

S'pore team sheds light on tapping solar power

A 'wonder material' known as perovskite could help sunny Singapore tap more sunlight than it ever could before. Audrey Tan looks at ongoing research at the Nanyang Technological University on how this material could revolutionise the local solar industry.



(From left) NTU's Energy Research Institute executive director Subodh Mhaisalkar with Associate Professor Sum Tze Chien and Assistant Professor Nripan Mathews. The trio are part of a team of scientists studying perovskites, which could be used in making solar panels. ST FILE PHOTO

Researchers at the Nanyang Technological University (NTU) and the Singapore-Berkeley Research Initiative for Sustainable Energy are looking into tandem cells made by layering perovskite – a man-made substance – over silicon. They have shown that such cells have efficiencies of over 20 per cent.

In comparison, most silicon solar cells have efficiencies of between 17 per cent and 18 per cent, although more expensive models have recorded efficiencies of up to 25 per cent, said Professor Subodh Mhaisalkar, executive director of NTU's Energy Research Institute.

The efficiency of a solar cell is the proportion of energy from the sun that it turns into electricity.

But Professor Subodh said tandem cells, if used in combination with conventional silicon cells, for example, could achieve efficiencies exceeding 25 per cent in a solar module, or solar panel, which is made up of many connected cells.

The NTU-made tandem cell works by layering translucent perovskite over opaque silicon. Each layer captures a different "type", or colour, of light.

Light is electromagnetic radiation, some of which can be seen and some of which is invisible to the human eye. Infrared and ultraviolet radiation, for example, cannot be seen. They lie at either end of the visible spectrum of light.

Silicon solar cells are able to convert near-infrared light into electricity. But they are less efficient for visible and ultraviolet light.

Perovskite, on the other hand, is better at converting visible and ultra-violet light into electricity.

"So when light enters through the perovskite cell, the visible part of the solar spectrum is absorbed.

"The near-infrared light is then transmitted to the silicon cell where it is absorbed," said NTU Assistant Professor Nripan Mathews, one of the scientists doing perovskite research.

Over at the Singapore-MIT Alliance for Research and Technology (Smart), scientists are working on gallium arsenide-silicon tandem cells, which have recorded efficiencies of up to 25 per cent.

Gallium arsenide tandem cells are more expensive to make than perovskite ones, but the former also have higher efficiencies and are more stable for use on rooftops, said Professor Armin Aberle, chief executive of the Solar Energy Research Institute of Singapore. The institute is working with both NTU and Smart on tandem cell research.

Prof Aberle said tandem cells could provide more solar power per rooftop, helping land-scarce Singapore harvest more solar energy than with standard silicon panels.

He added: "The question is when inexpensive high-efficiency tandem solar panels will be commercially available... This technology still needs a lot of research and development in the laboratory until it can be commercialised."

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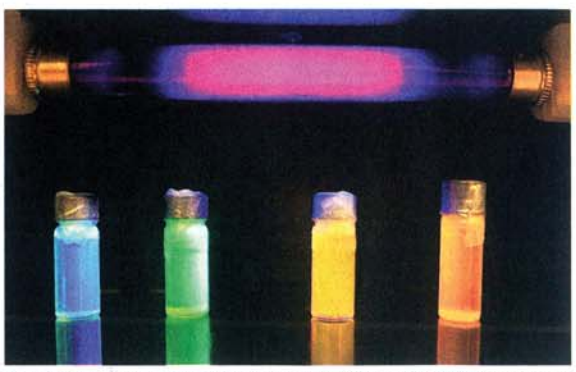
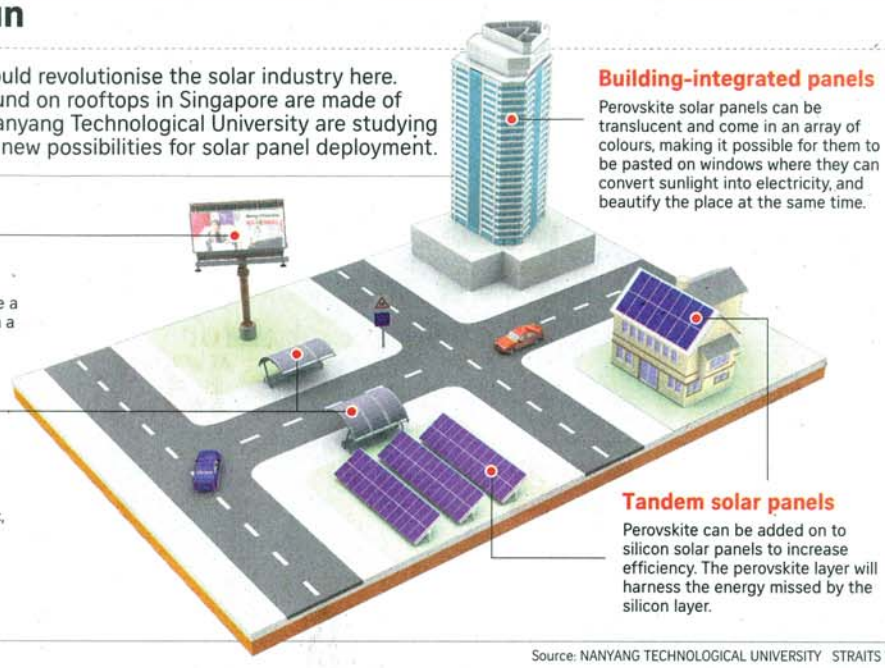


NTU scientists have discovered that other than absorbing energy for conversion into electricity, perovskite nanoparticles could also emit light in different colours, shown above. This allows for the potential application where a perovskite screen could function as both a display screen and solar panel. ST PHOTO: DAVE LIM

Soaking up the sun

A material called perovskite could revolutionise the solar industry here. Most solar panels currently found on rooftops in Singapore are made of silicon. But scientists at the Nanyang Technological University are studying how perovskite could open up new possibilities for solar panel deployment.



Source: NANYANG TECHNOLOGICAL UNIVERSITY STRAITS TIMES GRAPHICS: AUDREY TAN, BRYANDT LYN

Tiny particles pack a lot of power

Scientists at the Nanyang Technological University (NTU) and the Singapore-Berkeley Research Initiative for Sustainable Energy are looking into how tiny particles can unlock major success in the solar industry.

They are zooming into the quantum structure of a material known as perovskite, studying nanoparticles that measure just a few nanometres in length – about 10,000 times smaller than the breadth of a strand of human hair.

They found that when perovskite nanoparticles are exposed to light, each particle captures more light energy for conversion into electricity.

In comparison, a lot of this energy is lost through heat in conventional solar cells made of silicon.

These findings were published earlier this year in science journal Nature Communications.

One of the researchers who made the discovery, Associate Professor Sum Tze Chien, said: "Normal silicon solar cells waste a lot of energy through heat since they cannot convert the captured high-energy light into electricity.

"But much higher conversion efficiencies can be achieved if these high-energy 'hot' carriers can be converted to electricity."

Prof Sum, who is associate dean for research at NTU's College of Science, added that this discovery could pave the way for the development of hot carrier perovskite solar cells, which in theory could have efficiencies of up to 66 per cent.

This figure far outstrips the efficiencies of conventional land-based silicon solar cells, the highest of which is 25 per cent.

It also surpasses the more expensive solar cells used in space which have an efficiency of 28 per cent.

However, Prof Sum noted that much more research has to be done in this area before the technology becomes commercially available.

"The huge theoretical efficiency means we have a lot of room for improvement, and one of our main goals is to make perovskites generate more electricity with the same surface area as silicon solar cells, but at a much lower cost," he added.

The team also discovered that other than absorbing energy for conversion into electricity, perovskite nanoparticles could also emit light. This allows for the potential application where a perovskite screen could function as both a display screen and solar panel, said the scientists.

Professor Subodh Mhaisalkar, executive director of NTU's Energy Research Institute, said: "So, for instance, you could have the screen function as a solar panel in the day and, at night, it could double as a signboard or billboard. Developing solar technology that is better yet greener is a huge challenge, but perovskite is proving to be a very capable material, having demonstrated excellent properties for both harvesting and emitting light."

Audrey Tan

Solar panels can be flexible and pretty

Solar installations need not always be an eyesore.

Scientists at the Nanyang Technological University (NTU) have found a way for them to look good too.

The researchers have come up with solar cells made of perovskite, a man-made substance.

The cells can be translucent and come in an array of colours, making it possible for them to be pasted on windows where they can convert sunlight into electricity, and beautify the place at the same time.

The effect is much like sunlight streaming through a stained glass window.

Like silicon, the material used in most solar cells today, perovskite can convert sunlight into electricity.

However, unlike brittle silicon, perovskite is processed from solutions and can be printed onto plastic sheets, making flexible solar panels a possibility.

Last week, scientists from NTU and the Singapore-Berkeley Research Initiative for Sustainable Energy showed The Straits Times a prototype of what such a flexible panel could look like, by printing perovskite on a 30cm by 30cm plastic sheet.

First, the researchers mixed various liquid chemicals, including the perovskite, together.

The solution is then poured into a screen printer, such as those used in T-shirt printing businesses, and printed onto sheets of plastic.

The scientists demonstrated that perovskite could also be printed on glass sheets of the same size. In 2013, the researchers said they could only produce glass panels measuring barely 1cm by 1cm.

A challenge in scaling up the panels was ensuring that efficiency was not compromised, as larger panels are usually less efficient than smaller ones, due to factors such as increased electrical resistance.

The researchers' first glass panels with perovskite covered areas of 0.75 sq cm and had an efficiency of less than 2 per cent. But the 70 sq cm one unveiled last week had an efficiency of about 14 per cent, compared with the 17 to 18 per cent of conventional silicon solar panels found on rooftops.

However, silicon panels are not ideal for use on building facades or windows as they are opaque and would block out light, pointed out Professor Subodh Mhaisalkar, executive director of NTU's Energy Research Institute.

But perovskite-printed cells are still more efficient when compared to other thin-film solar cells suitable for use on facades that are available in the market.

For example, dye-sensitised solar cells, made of carbon-containing organic material, have efficiencies in the range of 10 per cent.

Assistant Professor Nripan Mathews from NTU's School of Materials Science and Engineering said: "Perovskite solar cells have many attractive properties for commercial use. They can be made semi-translucent, to be used as a tint for windows... and they can also be thin and flexible, conforming to different surfaces and objects."

Audrey Tan